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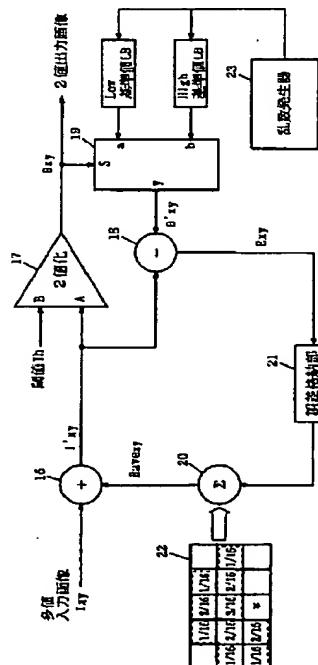
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(54)【発明の名称】 画像処理装置

(57)【要約】

【課題】 Snake-Lineテクスチャの発生を低減可能な画像処理装置を提供する。

【解決手段】 多値階調の入力画像を2値化処理可能な画像処理装置において、2値化誤差を算出する際の基準値(Low基準値LB, High基準値HB)に乱数発生器23で発生した乱数を加算した値を基準値B'xyとし、2値化誤差Exyに乱数が含まれるように構成した。





補正後のデータ  $I'_{xy}$  と所定のしきい値  $T_h$  との比較が行なわれて、その結果が output され、その結果に応じて 2 値化が行なわれる。これにより、次の(4)式に示す

$$B_{xy} = 1 \text{ if } xy \geq Th \text{ or } 0 \text{ if } xy < Th \quad \dots \dots \quad (4)$$

また、比較器10の比較結果はセレクタ12へも入力される。セレクタ12では、比較器10からの入力結果に応じて次の(5)式に示すように2値化誤差 $E_{xy}$ を算※

$$B' x y = HB \quad (B x y = 1) \text{ or } LB \quad (B x y = 0) \dots \dots \dots \quad (5)$$

上記(5)式において、HB(High基準値)およびLB(Low基準値)は、それぞれ、出力される画素濃度のダイナミックレンジの上限値と下限値で与えられる値であり、たとえば、 $HB = 1$ 、 $LB = 0$ となる。

$$E_{\text{X}} \cdot v \in V' \quad \text{and} \quad E_{\text{X}} \cdot v = B' \cdot v \quad \text{for all } v \in V.$$

減算器 11 の算出結果は誤差格納部 14 に格納され、加算器 9 に次の  $I x y$  が入力されるごとに積和演算器 13 にその格納データが出力される。積和演算器 13 は、入力データ  $I x y$  に応じて誤差格納部 14 に格納されている 2 値化誤差  $E_{11}, \dots, E_{1n}$  を順次読み出して重み付け係数  $K_{11}, \dots, K_{1n}$  と 2 値化誤差  $E_{21}, \dots, E_{2n}$  とを乗じ、重み付き平均誤差  $E_{avg}$  を算出する。そして、その結果を加算器 9 へ出力する。

【0012】以上、概説した誤差拡散法は、優れた解像度と階調性が得られる点にその特徴を有する。しかしながら、一様な濃度レベルの画像では、ある一定のバーチャンで誤差拡散が行なわれてしまうことに起因して、特に分散の少ない一様な濃度レベル画像を処理する際、Snake-Line(もしくはWorm-Line)テクスチャと呼ばれる独特の縞模様が発生するという欠点のあることが知られている。

【0013】図12に、従来のこの種の誤差拡散法によりSnake-Lineテクスチャが顕著に現れた画像処理結果例を示す。この画像処理結果を得ることとなつた処理対象の多値階調入力画像は、そもそも、文字“5”を除いて一様に画素濃度が分布する4つの領域から構成されているのであるが、2値化処理の結果、Snake-Lineテクスチャとよばれる独特的の縞模様が現れてしまい、画像の再現性が極めて悪いことがわかる。

【0014】かかる問題の解消を図るべく、たとえば、特開平3-243063号公報には、読み取り画像の注目画素濃度を2値化する際の2値化処理および誤差を拡散配分する際の誤差配分処理の主走査方向の向きを、所定期間またはランダムに反転することにより、Snake-Lineテクスチャの発生を低減させることができると示されている。

〔0015〕その他、特開平5-37781号公報には、拡散配分される誤差データを格納するメモリの読み出方向を乱数発生回路の出力に従い、ランダムに切り替えることにより、ドットの繋がりの周期性を断ち切り、これによりSnake-Lineテクスチャの発生を低減させることができると開示されている。

\* ように2値化画像を構成する画素の濃度データ  $B[x, y]$  が定められる。

(0008)

$$O(I' \times y < Th) \dots \dots \dots (4)$$

※出する際の基準値B' x yが選択されて、減算器11にその値が出力される。

(0009)

$$\perp B \quad (B x y = 0) \quad \dots \dots \dots \quad (5)$$

★【0010】次に、減算器11では、2値化誤差 $E_{xy}$ が、先の(1)式に対して、次の(6)式で算出されることになる。

{0011}

..... (6)

〔0016〕

【発明が解決しようとする課題】しかしながら、Snake-Lineテクスチャの発生を低減させるための従来のいすれの技術も、誤差拡散のフィードバック要素（2値化しきい値、周辺誤差重み付けフィルタの係数、ラスタスキヤンの方向など）のいすれかを乱数などによって制御するものであるために、Snake-Lineテクスチャの発生の低減には効果があるものの、注目画素に先行して算出された2値化誤差値、誤差拡散方向を大きく変化させてしまうことになる。このため、誤差拡散法本来のもつ、解像度と階調性を損ねてしまい、また、フィードバックループ内の処理系をより一層複雑なものにしてしまうという問題が生じていた。

【0017】本発明は係る実情に鑑み考え出されたものであり、その目的は、誤差拡散法本来のもつ、解像度と階調性を極力損ねることなく、Snake-Lineテクスチャの発生を低減可能な画像処理装置を提供することである。

{00181}

【課題を解決するための手段】請求項 1 に記載の発明は、Mが3以上のM値階調画像を誤差拡散法を利用して2値階調再現可能な画像処理装置であって、前記M値階調画像を構成する画素のうち2値階調再現対象である注目画素の周辺画素に拡散すべき拡散濃度値を演算する拡散濃度値演算手段と、乱数を発生する乱数発生手段とを含み、前記拡散濃度値演算手段は、2値階調再現前の前記注目画素の濃度値と、2値階調再現後の前記注目画素の階調を条件にして定められる基準値と、前記乱数発生手段で発生する乱数とを使用して前記拡散濃度値を演算可能であることを特徴とする。

〔0019〕請求項1に記載の発明によると、前記拡散濃度値の演算に前記乱数発生手段で発生する乱数が使用されるために、分散の少ない一様な濃度レベルの画像を処理する場合において、ある一定のパターンで誤差拡散が行なわれてしまうことを防止でき、Snake-Lineテクスチャの発生を低減できる。

50 [0020] 請求項2に記載の発明は、請求項1に記載

の発明の構成に加えて、前記拡散濃度値演算手段は、前記基準値に前記乱数を加算可能な乱数加算手段を含み、2値階調再現前の前記注目画素の濃度値と、前記乱数加算手段の加算結果との差を求ることにより前記拡散濃度値を演算することを特徴とする。

【0021】請求項2に記載の発明によると、2値階調再現前の前記注目画素の濃度値と、前記乱数加算手段の加算結果との差を求ることにより前記拡散濃度値が演算される。

【0022】請求項3に記載の発明は、請求項1に記載の発明の構成に加えて、前記M値階調画像を構成する画素領域のうち前記注目画素を含む所定の画素領域の画素濃度に基づいて、前記基準値の大きさを設定する基準値設定手段を含むことを特徴とする。

【0023】請求項3に記載の発明によると、前記M値階調画像を構成する画素領域のうち前記注目画素を含む所定の画素領域の画素濃度に基づいて、前記基準値の大きさが設定されるために、さらに2値化対象領域に応じたガンマ特性を得ることができる。

【0024】請求項4に記載の発明は、請求項1に記載の発明の構成に加えて、前記M値階調画像を構成する画素領域のうち前記注目画素を含む所定の画素領域の画素濃度に基づいて、前記乱数を使用して前記拡散濃度値を演算すべきか否かを判別する判別手段とを含み、前記拡散濃度値演算手段は、前記乱数を用いて前記拡散濃度値を演算すべき旨の判別が前記判別手段でなされたことを条件に、前記乱数を使用して前記拡散濃度値を演算することを特徴とする。

【0025】請求項4に記載の発明によると、前記乱数を用いて前記拡散濃度値を演算すべき旨の判別が前記判別手段でなされたことを条件に、前記乱数を使用して前記拡散濃度値が演算されるために、必要性のある領域にのみ、前記乱数を使用した前記拡散濃度値の演算が行なわれる。

【0026】請求項5に記載の発明は、請求項4に記載の発明の構成に加えて、前記判別手段は、前記画素領域内の画素濃度の最大値と最小値を基に前記判別を行なうことを特徴とする。

【0027】請求項5に記載の発明によると、前記画素領域内の画素濃度の最大値と最小値を基に前記判別が行なわれるために、判別処理が容易となる。

【0028】

〔発明の実施の形態〕以下、図面を参照しつつ、本発明における実施の形態の1つである画像処理装置について説明する。

【0029】図1は、画像処理装置1の構成および処理概要を説明するためのブロック図である。画像処理装置1は、MPU2、CCDなどの光電変換素子およびこれを走査する駆動系からなる画像入力装置3、A/D変換装置4、Log変換装置5、先鋭度補正装置(MTF補

正装置)6、ガンマ補正装置7、画像2値化装置8、画像記録装置9を含む。

【0030】画像入力装置3は、たとえば連続階調画像、線画などからなる混在原稿を読み取って標本化アナログ信号を生成する。A/D変換装置4は、画像入力装置3で生成された標本化アナログ信号を1画素がたとえば8ビット(256階調)の値を持つ連続階調反射率データとして量子化する。Log変換装置5は、量子化された連続階調反射率データを対数変換して8ビット連続階調濃度データを算出する。先鋭度補正装置(MTF補正装置)6は、たとえばラブラシアンフィルタなどのデジタルフィルタを用いて、8ビット連続階調濃度データ画像の先鋭度補正を行なう。ガンマ補正装置7は、画像入力装置3と画像記録装置9の階調カーブの差異を補正して画像処理装置1全体として望ましいガンマ特性を実現するために、ガンマ補正を行なう。このガンマ補正は、たとえば256ワード8ビット程度のLUT(ルックアップテーブル)として機能するRAMを用いて、MPU2により非線形ガンマ補正データが設定されることにより行なわれる。画像2値化装置8は、後述する誤差拡散2値化法を用いて、ガンマ補正された8ビット連続階調濃度データを明暗に応じた1ビット2値データに変換する。変換された1ビット2値データは、電子写真プリンタあるいはインクジェットプリンタなどからなる画像記録装置9により所定の記録媒体に印字される。

【0031】図2は、画像処理装置1で行なわれる誤差拡散2値化処理の第1実施形態を示すブロック線図である。また、図3は、図2の誤差拡散2値化処理の処理手順を示すフローチャートである。図2および図3を参照しながら、第1実施形態に係る誤差拡散2値化処理の処理内容を以下に詳細に説明する。

【0032】図2を参照して、従来技術として説明した図11のブロック線図と比較して、この第1実施形態が異なる点は、High基準値HBおよびLow基準値LBに対して乱数を加算する乱数発生器23がさらに設けられている点にある。セレクタ19へは、High基準値HBおよびLow基準値LBに対して乱数が加算された値が入力され、いずれか一方の値が2値化誤差Exy算出のための基準値B'xyとして選択されて減算器18に出力されることになる。

【0033】図3のフローチャートに基づいて処理内容を説明すると、まず、注目画素データIx yが加算器16に入力されたか否かが判断される(S1)。注目画素データIx yは、前述のガンマ補正された8ビット連続階調濃度データを構成する画素の1つであって、2値化対象となる画素の濃度データである。

【0034】注目画素の入力がない場合には処理が終了したか否か、すなわち、多値階調入力画像のすべての画素について2値化処理が終了したか否かが判断される(S13)。

【0035】そして、すべての画素について2値化処理が終了していない限り処理が再びS1に戻る。

【0036】注目画素が入力されれば、この注目画素の濃度データに加算すべき重み付き平均誤差E<sub>ave xy</sub>が算出され(S2)、この重み付き平均誤差E<sub>ave xy</sub>がI<sub>xy</sub>に加算されてI'<sub>xy</sub>とされる(S3)。E<sub>ave xy</sub>は、図2に示すように、誤差重み付けフィルタ22を使用した処理により算出される値であり、入力値をフィードバックして算出される。

【0037】次に、比較器17において、このI'<sub>xy</sub>が2値化処理のしきい値Thよりも大きいか否かが判断される(S4)。I'<sub>xy</sub>がThよりも大きい場合には2値化後の出力画素濃度データB<sub>xy</sub>が1に設定される(S5)。一方、しきい値Th以下である場合には出力画素濃度データB<sub>xy</sub>が0に設定される(S6)。また、設定されたB<sub>xy</sub>は、セレクタ19へも出力される。

【0038】次に、乱数発生器23より乱数Z<sub>rand</sub>(randmax)が抽出される(S7)。乱数Z<sub>rand</sub>(以下、乱数Zと略す)が採り得る値の範囲は、誤差拡散法により得られる画像の画質を損ねることのない範囲で適宜定めることができるが、たとえば、画素のダイナミックレンジの10%~20%程度とすることができる。今、ダイナミックレンジを0~1とすると、乱数Zの値は0.1~0.2となる。

【0039】次に、S5またはS6で設定されたB<sub>xy</sub>が1であるか否かが判断される(S8)。B<sub>xy</sub>が1の場合には、High基準値HBに乱数Zの加算された値がセレクタ19で選択され、基準値B'<sub>xy</sub>として減算器18に出力される(S9)。一方、B<sub>xy</sub>が1でない場合には、すなわちB<sub>xy</sub>=0であり、Low基準値LBに乱数Zの加算された値がセレクタ19で選択され、基準値B'<sub>xy</sub>として減算器18に出力される(S10)。

【0040】次に、補正済の画素データI'<sub>xy</sub>と、2値化結果から得られた基準値B'<sub>xy</sub>とから2値化誤差Exyが算出され、誤差格納部21に格納される(S11)。

【0041】次に、注目画素位置が更新され(S12)、すべての画素について2値化処理が終了していない場合には再度処理が前記S1に戻り(S13)、上記処理が繰返し行なわれる。

【0042】以上説明したようにこの第1実施形態では、2値化誤差Exyを算出するための基準値B'<sub>xy</sub>が、乱数Zを使用して演算されているため、特に分散の少ない一様な濃度レベルの画像を2値化処理する際に発生しがちなスネークラインテクスチャと呼ばれる独特の縞模様の低減を図ることができる。また、2値化処理する際のしきい値Thを変化させることなく、2値化誤差Exyのみを乱数を用いてランダムに変化させるように

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処理がなされるため、誤差拡散のフィードバック要素のいずれかを乱数によって制御する場合と比較して、誤差拡散法の特徴である、優れた階調表現能力が低下してしまうことを極力防止できる。

【0043】図4は、本実施形態に示す誤差拡散2値化法により処理され、出力された画像例を示す図である。処理対象の多値階調入力画像は、図12に示した処理結果が得られた多値階調入力画像と同一である。図示で明らかなるとおり、同一の多値階調入力画像を処理した結果、図4では、従来の誤差拡散2値化法により処理され、出力された画像(図12)に比較してスネークラインテクスチャが低減し、一様な画素分布がより忠実に再現されていることがわかる。一方、文字“5”については、乱数を用いて誤差分散を行なったにも係わらず、図12と比較して画像の再現性に遜色なく線画が明瞭に再現されていることがわかる。

【0044】図5は、画像処理装置1で行なわれる誤差拡散2値化処理の第2実施形態を示すブロック線図である。第1実施形態として説明した図2のブロック線図と比較してこの第2実施形態が異なる点は、注目画素データI<sub>xy</sub>が入力される領域判別部24がさらに設けられている点である。

【0045】図6には、領域判別部24の構成が示されている。領域判別部24は、ラインメモリ27、最大値/最小値検出フィルタ28、LUT(ルックアップテーブル)29、30を有する。入力される注目画素データI<sub>xy</sub>は、ラインメモリ27により順次記憶される。このラインメモリ27は、4ライン分記憶可能のように、4つ設けられている。そして、新たに注目画素データI<sub>xy</sub>が入力されるごとにその注目画素を中心にもむら×5局所領域のa~xまでの25画素が抽出されて、最大値/最小値検出フィルタ28により、25画素の画素濃度の「最大値」、「最小値」、「最大値-最小値」がそれぞれ検出される。25画素の「最大値」および「最大値-最小値」は、LUT29へ、「最小値」および「最大値-最小値」は、LUT30へ、それぞれ出力される。LUT29は、最大値/最小値検出フィルタ28から入力される値に応じたHigh基準値HBを内部に記憶されているテーブルデータから選択して加算器25へ出力する。また、LUT30は、最大値/最小値検出フィルタ28から入力される値に応じたLow基準値LBを内部に記憶されているテーブルデータから選択して加算器26へ出力する。

【0046】図7には、LUT29に入力される「最大値-最小値」と、LUT29で選択されるHigh基準値HBとの関係を例示する図が示されている。また、図8には、LUT30に入力される「最大値-最小値」と、LUT30で選択されるLow基準値LBとの関係を例示する図が示されている。これらの図では、縦軸がHigh基準値HB(Max)またはLow基準値LB

(Min) を示し、横軸が「最大値-最小値」(Max-Min) を示す。また、入力される多値階調画像の階調を8ビット(0~255)としている。

【0047】「最大値-最小値」の値がより大きくなる程、その局所領域はたとえば文字領域などとしての特性が強く現れるように2値化処理する必要があり、「最大値-最小値」の値がより小さくなる程、その局所領域はたとえば写真領域などとしての特性が強く現れるように2値化処理する必要がある。図7、図8に示す関係に従ってHigh基準値HBおよびLow基準値LBが変化して選択されるようにLUT29, 30のテーブルを設定すれば、文字領域または文字領域に適したガンマ特性を得ることができる。

【0048】再び、図5を参照して、領域判別部24で設定されたHigh基準値HB、Low基準値LBは、それぞれ加算器25、加算器26に入力される。これ以後、第1実施形態と同様に乱数発生器23で発生した乱数がHigh基準値HB、Low基準値LBに加算されてセレクタ19に入力される。以下の処理は第1実施形態と同様であるために、ここではこれ以降のブロック線図の詳細な説明を省略する。

【0049】以上説明したように、この第2実施形態によれば、たとえば、文字領域あるいは写真領域に適したガンマ特性を得ることができ、かつ、High基準値HB、Low基準値LBへの乱数加算により、第1実施形態と同様にSnake-Lineテクスチャを低減させることができる。したがって、たとえば、図4の出力画像が得られた元の多値階調画像をこの第2実施形態で処理した場合、この第2実施形態の方が第1実施形態に比較して、より文字領域"5"の再現性が高くなることが期待される。

【0050】図9は、画像処理装置1で行なわれる誤差拡散2値化処理の第3実施形態を示すブロック線図である。なお、この図9では、第2実施形態の図5と構成が同一である部分については図示を省略している。具体的には、図5に示した乱数発生器23、領域判別部24、加算器25、加算器26から成る構成部分をこの図9の構成に置き換えた構成が第3実施形態に係わる全体ブロック線図となる。

【0051】第2実施形態として説明した図5のブロック線図と比較して、この第3実施形態が作用的に異なる点は、注目画素\*を中心にもつ5×5局所領域の画素の画素濃度の「最大値-最小値」に応じて、セレクタ19(図5参照)に出力するHigh基準値HBおよびLow基準値LBに乱数を加算するか否かが判断される点にある。つまり、常にHigh基準値HBおよびLow基準値LBに乱数を加算する第2実施形態または第1実施形態と異なり、この第3実施形態では、5×5局所領域の状態に応じて乱数加算の必要性の有無(Snake-Lineテクスチャの発生の可能性の有無)が判断され

るのである。

【0052】図9および図10さらには図5を参照しながら、第3実施形態に係わる誤差拡散2値化処理の処理を説明すると、まず、注目画素データIx'yが加算器16に入力されたか否かが判断され(S21)、注目画素データが入力されれば、重み付き平均誤差Eavexyの算出(S22)、Ix'yの算出(S23)が行なわれる。次に、Ix'yと2値化処理のしきい値Th1とが比較されて(S4)、出力画素濃度データBxyが算出される(S25、S26)。

【0053】次に、領域判別部24において、注目画素\*を中心に含む5×5局所領域の画素の画素濃度の「最大値-最小値」(Max-Min)が演算される(S27)。領域判別部24は、第2実施形態と同様の最大値/最小値検出フィルタ28とラインメモリ27を有している。最大値/最小値検出フィルタ28は、このS27で5×5局所領域の画素の「最大値-最小値」を検出する。なお、第2実施形態と異なり、領域判別部24にはLUT29, 30は構成されていない。

【0054】次に、「最大値-最小値」(Max-Min)が、しきい値Th2より小さいか否かが比較器31で判断される。このTh2は、5×5局所領域が特に分散の少ない一様な濃度分布特性を有する領域であるか否か、換言すれば、乱数Zを使用することなく2値化処理した場合にSnake-Lineテクスチャの発生し得る領域であるか否かを判別するためのしきい値である。「最大値-最小値」が、しきい値Th2より小さい場合には、5×5局所領域が特に分散の少ない一様な濃度分布特性を有する領域であると考えられるため、比較器31からその旨を示す信号がセレクタ32, 33に出力される。

【0055】セレクタ32は、比較器31から入力される信号に応じて、High基準値HBに乱数発生器23から入力される乱数Zを加算するか否かを選択し、セレクタ19(図5参照)にHigh基準値HBを出力する。一方、セレクタ33は、比較器31から入力される信号に応じて、Low基準値LBに乱数発生器23から入力される乱数Zを加算するか否かを選択し、セレクタ19(図5参照)にLow基準値LBを出力する。

【0056】したがって、S28でYESの判断がなされれば、セレクタ32, 33でHigh基準値HBおよびLow基準値LBに乱数Zが加算され(S29)、加算結果がHigh基準値HBおよびLow基準値LBとしてセレクタ19に出力される(S30)。一方、S28でNOの判断がなされれば、乱数Zが加算されることなく、セレクタ32, 33からHigh基準値HBおよびLow基準値LBがそのままセレクタ19に出力される(S30)。

【0057】なお、乱数Zの値の範囲は、第1実施形態と同様に、たとえば、画素のダイナミックレンジの10

%～20%程度とすることが考えられる。

【0058】次に、出力画素濃度データB'xyの値に応じて、2値化誤差を算出する際の基準値B'xyがHigh基準値HBまたはLow基準値LBに設定され(S31、S32、S33)、2値化誤差E'xyが算出される(S34)。その後、注目画素位置が更新され(S35)、すべての画素について2値化処理が終了するまで(S36)、前記処理が繰返し行なわれる。

【0059】以上説明したように、この第3実施形態によれば、5×5局所領域の状態に応じて乱数加算の必要性の有無(Snake-Lineテクスチャの発生の可能性の有無)が判断され、5×5局所領域が、たとえば文字領域のような場合には乱数は加算されない。したがって、Snake-Lineテクスチャの発生の可能性の低い領域まで徒に乱数加算処理が行なわれて却って画質の低下を招いてしまう不都合を防止できる。また、乱数加算処理が無駄に行なわれて2値化処理の速度を低下させてしまうことをも防止できる。このことは、特に処理速度に難の多い誤差拡散法において、効果的な作用をもたらす。

【0060】次に、以上説明した各実施形態の変形例を列挙する。

(1) 亂数Zは、High基準値HBおよびLow基準値LBに加算されているが、High基準値HBおよびLow基準値LBから減算するように構成してもよい。

【0061】(2) 2値化誤差算出の手順として、乱数ZがHigh基準値HBまたはLow基準値LBに加算された後、この値がI'xyから減算されるように構成しているが、I'xyから乱数Zを減算した後に、High基準値HBまたはLow基準値LBを減算してもよい。この場合、たとえば図2において、加算器16と減算器18との間に減算器を設け、乱数発生器26は乱数Zをその減算器に出力してやるよう構成すればよい。

【0062】(3) 亂数発生器23は、High基準値HBとLow基準値LBとでそれぞれ異なる乱数を発生するように構成してもよい。この場合、乱数の範囲を同一として乱数の発生周期などを変化させるようしてもよく、あるいは、乱数の範囲が異なるようにしてもよい。

【図面の簡単な説明】

\* 【図1】画像処理装置1の概略構成を示すブロック図である。

【図2】画像処理装置1の制御処理を説明するためのブロック線図である(第1実施形態)。

【図3】画像処理装置1の制御処理を説明するためのフローチャートである(第1実施形態)。

【図4】画像処理装置1による2値化処理によりSnake-Lineテクスチャの低減が図られた出力画像例を示す図である。

10 10 【図5】画像処理装置1の制御処理を説明するためのブロック線図である(第2実施形態)。

【図6】画像処理装置1の制御処理を説明するためのブロック線図である(第2実施形態)。

【図7】画像処理装置1で選択されるHigh基準値HB(Max)と、5×5局所領域の画素の「最大値-最小値」との関係を例示する図である。

【図8】画像処理装置1で選択されるLow基準値LB(Min)と、5×5局所領域の画素の「最大値-最小値」との関係を例示する図である。

20 20 【図9】画像処理装置1の制御処理を説明するためのブロック線図である(第3実施形態)。

【図10】画像処理装置1の制御処理を説明するためのフローチャートである(第3実施形態)。

【図11】従来の画像処理装置の制御処理を説明するためのブロック線図である。

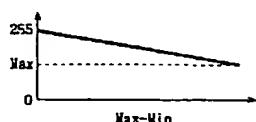
【図12】従来の画像処理装置による2値化処理により顕著に現れるSnake-Lineテクスチャを示す図である。

#### 【符号の説明】

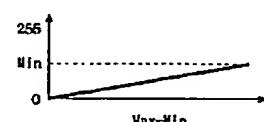
- 30 1 画像処理装置
- 8 画像2値化装置
- 17 比較器
- 19 セレクタ
- 21 誤差格納部
- 22 誤差重み付けフィルタ
- 23 亂数発生器
- 24 領域判別部
- 27 ラインメモリ
- 28 最大値／最小値検出フィルタ
- 29, 30 LUT(ルックアップテーブル)
- 31 比較器
- 32, 33 セレクタ

\* 40

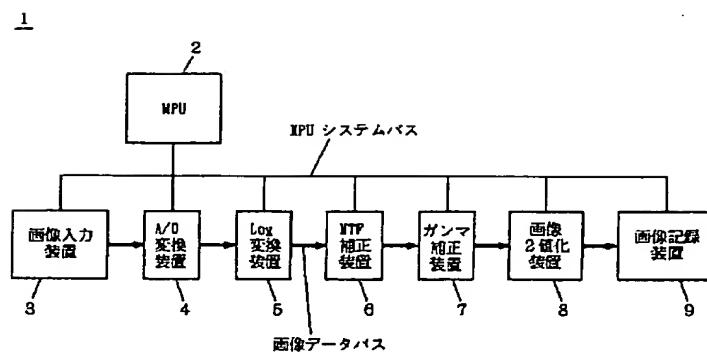
【図7】



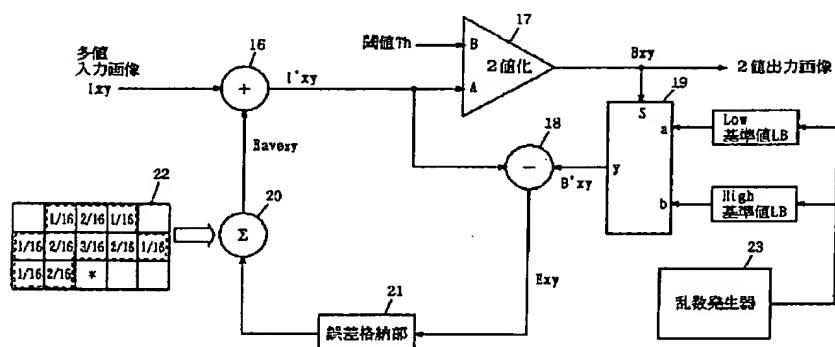
【図8】



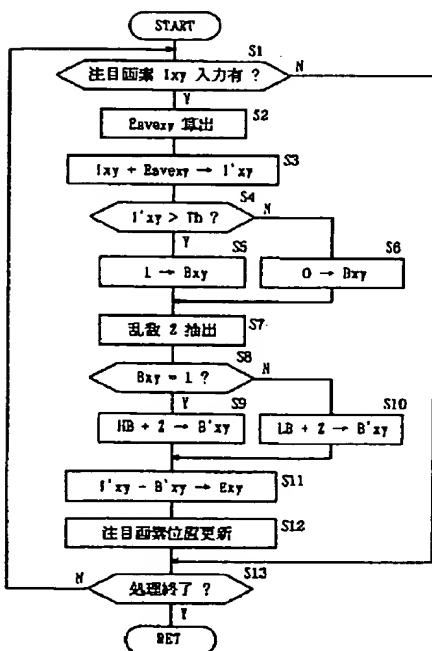
【図1】



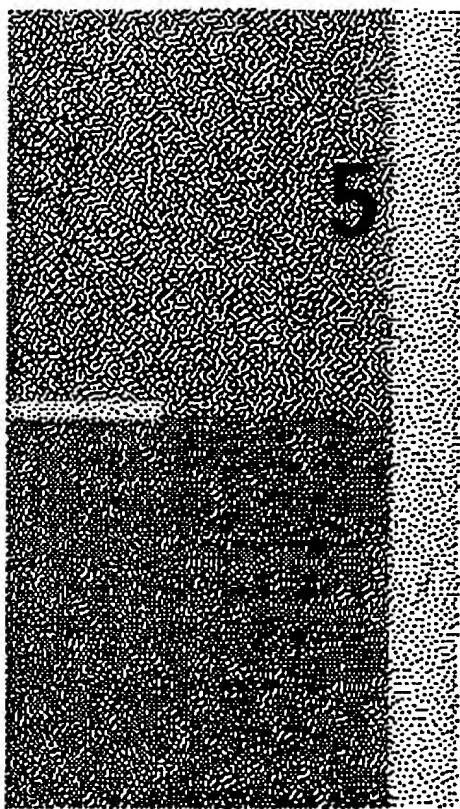
【図2】



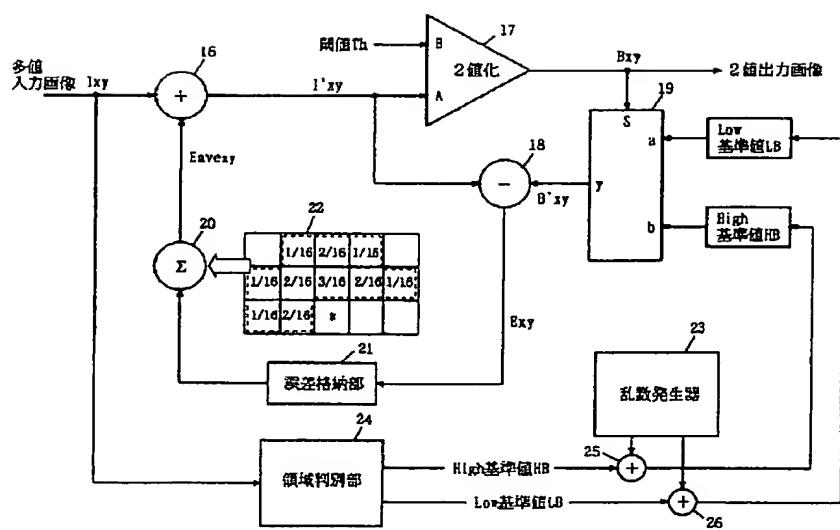
【図3】



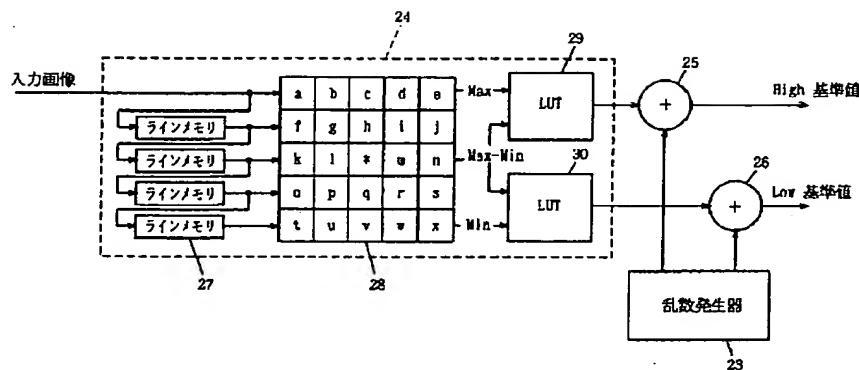
【図4】



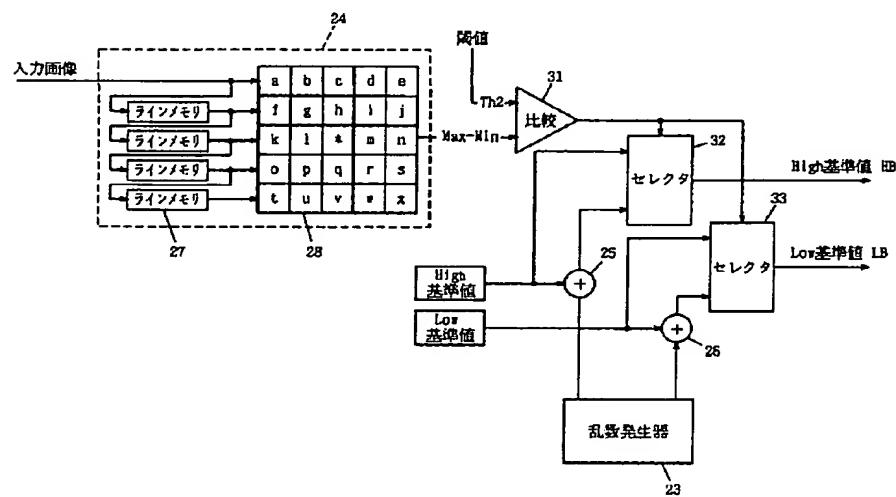
【図5】



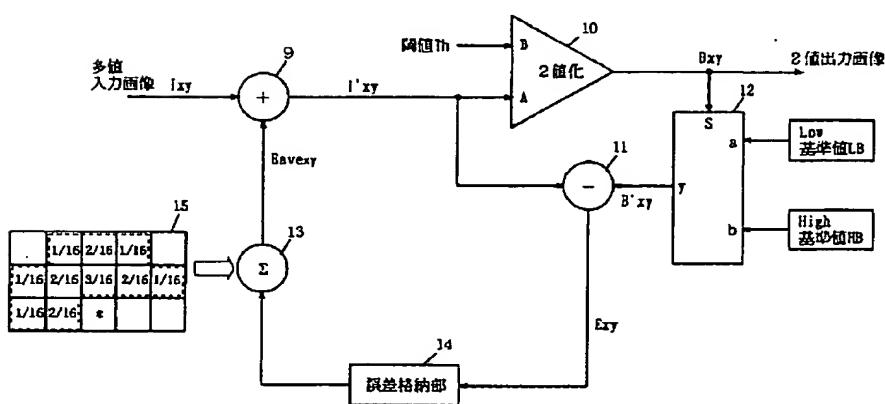
【図6】



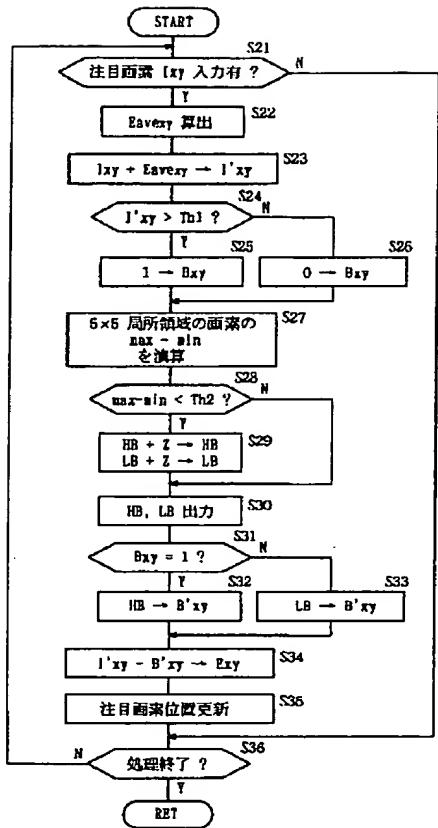
【図9】



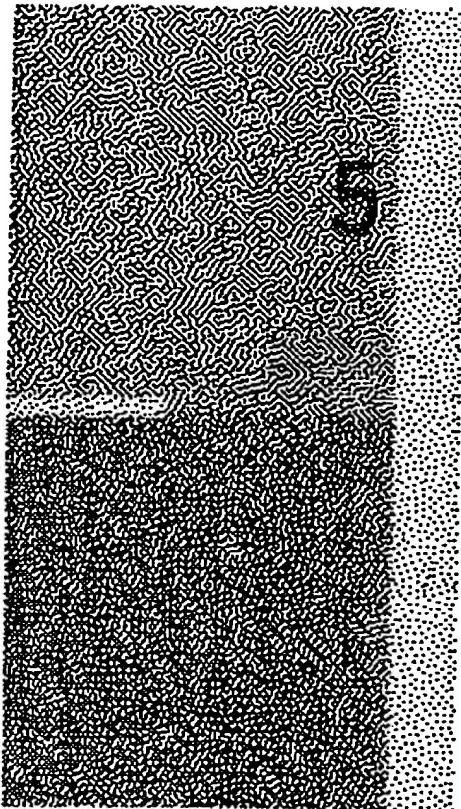
【図11】



【図10】



【図12】



Japanese Unexamined Patent Publication No.

11-136510

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CLAIMS

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[Claim(s)]

[Claim 1] M is the image processing system in which binary gradation reappearance is possible about three or more M value gradation pictures using an error diffusion method. A diffuse density value operation means to calculate the diffuse density value which should be diffused in the circumference pixel of the attention pixel which is a candidate for binary gradation reappearance among the pixels which constitute the aforementioned M value gradation picture. A random-number-generation means to generate a random number is included. the aforementioned diffuse density value operation means The image processing system characterized by an operation of the aforementioned diffuse density value being possible using the concentration value of the aforementioned attention pixel before binary gradation reappearance, the reference value defined on condition that the gradation of the aforementioned attention pixel after binary gradation reappearance, and the random number generated with the aforementioned random-number-generation means.

[Claim 2] The aforementioned diffuse density value operation means is an image processing system according to claim 1 characterized by calculating the aforementioned diffuse density value including a random number addition means by which the aforementioned random number can be added to the aforementioned reference value, by searching for the difference of the concentration value of the aforementioned attention pixel before binary gradation reappearance, and the addition result of the aforementioned random number addition means.

[Claim 3] The image processing system according to claim 1 characterized by including a reference-value setting means to set up the size of the aforementioned reference value, based on the pixel concentration of the predetermined pixel field which contains the aforementioned attention pixel among the pixel fields which constitute the aforementioned M value gradation picture.

[Claim 4] It is based on the pixel concentration of the predetermined pixel field which contains the aforementioned attention pixel among the pixel fields which constitute the aforementioned M value gradation picture. A distinction means to distinguish whether the aforementioned diffuse density value should be calculated using the aforementioned random number is included. the aforementioned diffuse density value operation means The image processing system according to claim 1 characterized by calculating the aforementioned diffuse density value using the aforementioned random number on condition that the distinction of a purport which should calculate the aforementioned diffuse density value using the aforementioned random number was made with the aforementioned distinction means.

[Claim 5] The aforementioned distinction means is an image processing system according to claim 4 characterized by performing the aforementioned distinction based on the maximum and the minimum value of pixel concentration in the aforementioned pixel field.

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[Translation done.]

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## DETAILED DESCRIPTION

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### [Detailed Description of the Invention]

[0001]

[The technical field to which invention belongs] As for this invention, M is related with the image processing system in which binary gradation reappearance is possible in three or more M value gradation pictures using an error diffusion method.

[0002]

[Description of the Prior Art] There is an image processing system in which binary gradation reappearance is possible using an error diffusion method about the multiple-value gradation picture inputted into what is known from the former as this kind of an image processing system. The error diffusion method used with this kind of conventional image processing system will be the method of diffusing the difference (binary-ized error) of the concentration of the attention pixel of a read picture, and display concentration in the predetermined circumference pixel using the predetermined error diffusion matrix, and if it puts in another way, after making it spread and performing weighting, it will be the method of computing display concentration a predetermined rate every about the binary-ized error of a circumference pixel predetermined to the concentration of an attention pixel. The outline is explained below.

[0003] Drawing 11 is the block diagram showing the conventional error diffusion method. It is  $I'_{xy}$  ( $0 \leq I'_{xy} \leq 1$ ) about the concentration data of each pixel which constitutes a multiple-value gradation input picture.

It is  $B_{xy}$  ( $B_{xy}=0$  or  $1$ ) about the concentration data of each pixel which constitutes the binary-ized picture outputted corresponding to  $I'_{xy}$ .

Then, when not taking into consideration amendment by the weighted-mean error  $Eav_{xy}$  mentioned later, the binary-ized error  $E_{xy}$  is computed by the following (1) formula.

[0004]

$$E_{xy} = I'_{xy} - B_{xy} \quad \dots (1)$$

An error diffusion method is technique which averages the binary-ized error and is made small by diffusing a binary-ized error in a circumference pixel, and the error weighting filter 15 used for drawing 11 in case error diffusion of the binary-ized error of a circumference pixel is carried out at a processing-object pixel is shown. \* It is the pixel (especially this pixel is called attention pixel) of a processing object, and error diffusion of the binary-ized error  $E_{xy}$  of a circumference pixel [finishing / other processings of the position which belongs within the dotted-line limit of the error weighting filter 15] is carried out to the pixel data  $I'_{xy}$  of this attention pixel by the weighting coefficient (1/16, 2/16, 3/16) illustrated, respectively, and the concentration data of the attention pixel  $I'_{xy}$  are amended. Therefore, the binary-ized error  $E_{xy}$  shown in previous (1) formula based on data  $I'_{xy}$  after amendment of the attention pixel data  $I'_{xy}$  is computed in fact, and as shown in drawing 11, the error feedback loop for error diffusion is formed. If the data correction value of the attention pixel data  $I'_{xy}$  is set to  $Eav_{xy}$ , data  $I'_{xy}$  after amendment will be computed by the following (2) formulas.

[0005]

$$I'_{xy} = I'_{xy} + Eav_{xy} \quad \dots (2)$$

Here, correction value  $Eav_{xy}$  is a weighted-mean error over the inputted attention pixel data  $I'_{xy}$ , and if the weighting coefficient of the error weighting filter 15 is set to  $K_i$  and  $j$  ( $i$  is the matrix size of main scanning direction,  $i=5$  and  $j$  are the matrix sizes of the direction of vertical scanning, for example, it is  $j=3$ ), it will be computed by the following (3) formulas.

[0006]

$$Eav_{xy} = \sigma (K_i, j \times E_i, j) \quad \dots (3)$$

In drawing 11, 9 is the concentration data of an attention pixel, and an adder which performs addition with the weighted-mean error  $Eav_{xy}$  of the circumference error, and outputs data  $I'_{xy}$  after amendment by the above-mentioned formula (2) to the subtractor 11 for the comparator 10 for binary-izing, and binary-ized error calculation.

[0007] In a comparator 10, comparison with data  $I'_{xy}$  after the amendment obtained by the above-mentioned (2) formula and predetermined threshold  $Th$  is performed, the result is outputted and binary-ization is performed according to the result. The concentration data  $B_{xy}$  of the pixel which constitutes a binary-ized picture by this as shown in the following (4) formulas are defined.

[0008]

$$B_{xy} = 1(I'_{xy} \geq Th) \text{ or } 0(I'_{xy} < Th) \quad \dots (4)$$

Moreover, the comparison result of a comparator 10 is inputted also into a selector 12. In a selector 12, as shown in the following (5) formulas according to the input result from a comparator 10, reference-value  $B'_{xy}$  at the time of computing the binary-ized error  $E_{xy}$  is chosen, and the value is outputted to a subtractor 11.

[0009]

$B'xy=HB$  ( $Bxy=1$ ) or  $LB$  ( $Bxy=0$ ) ..... (5)

In the above-mentioned (5) formula, HB (High reference value) and LB (Low reference value) are values given by the upper limit and lower limit of a dynamic range of the pixel concentration outputted, respectively, for example, are set to  $HB = 1$  and  $LB = 0$ .

[0010] Next, in a subtractor 11, the binary-ized error  $E_{xy}$  will be computed by the following (6) formulas to previous (1) formula.

[0011]

$E_{xy}=I'_{xy}-B'_{xy}$  ..... (6)

The calculation result of a subtractor 11 is stored in the error storing section 14, and whenever the next  $I_{xy}$  is inputted into an adder 9, the storing data is outputted to the sum-of-products computing element 13. The sum-of-products computing element 13 reads the binary-ized error  $E_i$  stored in the error storing section 14 according to the input data  $I_{xy}$ , and  $j$  one by one, multiplies by the weighting coefficient  $K_{i,j}$ , and the binary-ized error  $E_i$  and  $j$ , and computes the weighted-mean error  $E_{av_{xy}}$ . And the result is outputted to an adder 9.

[0012] As mentioned above, the outlined error diffusion method has the feature at the outstanding resolution and the point that gradation nature is obtained. However, in case it originates in error diffusion being performed by a certain fixed pattern and a uniform concentration level picture with little distribution is processed especially, it is known for the picture of uniform concentration level that there is a fault that the peculiar striped pattern called Snake-Line (or Worm-Line) texture occurs.

[0013] The example of an image-processing result to which the Snake-Line texture appeared notably by this conventional kind of error diffusion method in drawing 12 is shown. Although the multiple-value gradation input picture of the processing object which will obtain this image-processing result consists of fields which are four over which pixel concentration is uniformly distributed except for character "5" primarily, as a result of binary-ized processing, the peculiar striped pattern called Snake-Line texture appears, and it is understood that the repeatability of a picture is very bad.

[0014] Reducing generating of a Snake-Line texture is indicated by JP,3-243063,A a predetermined period or by making it reversed at random in the sense of the main scanning direction of the error distribution processing at the time of carrying out diffusion distribution of the binary-ized processing at the time of making attention pixel concentration of a read picture binary, and the error to aim at the dissolution of this problem.

[0015] In addition, by changing at random the read-out direction of the memory which stores in JP,5-37781,A the error data by which diffusion distribution is carried out according to the output of a random-number-generation circuit, the periodicity of relation of a dot is severed and reducing generating of a Snake-Line texture by this is indicated.

[0016]

[Problem(s) to be Solved by the Invention] However, any conventional technology for reducing generating of a Snake-Line texture Since it is what controls either of the feedback elements (a binary-ized threshold, the coefficient of a circumference error weighting filter, the direction of a raster scan, etc.) of error diffusion by the random number etc. Although there is an effect in reduction of generating of a Snake-Line texture, the binary-ized error value and the error diffusion direction which were computed by preceding with an attention pixel are made to change a lot. For this reason, the resolution and gradation nature which error diffusion method original has were spoiled, and the problem of making the processor within the feedback loop much more complicated had arisen.

[0017] this invention is invented in view of the starting actual condition, and the purpose is offering the image processing system which can reduce generating of a Snake-Line texture, without spoiling the resolution and gradation nature which error diffusion method original has as much as possible.

[0018]

[Means for Solving the Problem] M of invention according to claim 1 is the image processing system in which binary gradation reappearance is possible about three or more M value gradation pictures using an error diffusion method. A diffuse density value operation means to calculate the diffuse density value which should be diffused in the circumference pixel of the attention pixel which is a candidate for binary gradation reappearance among the pixels which constitute the aforementioned M value gradation picture. A random-number-generation means to generate a random number is included. the aforementioned diffuse density value operation means It is characterized by an operation of the aforementioned diffuse density value being possible using the concentration value of the aforementioned attention pixel before binary gradation reappearance, the reference value defined on condition that the gradation of the aforementioned attention pixel after binary gradation reappearance, and the random number generated with the aforementioned random-number-generation means.

[0019] Since the random number generated with the aforementioned random-number-generation means is used for the operation of the aforementioned diffuse density value according to invention according to claim 1, when processing the picture of uniform concentration level with little distribution, it can prevent that error diffusion will be performed by a certain fixed pattern, and generating of a Snake-Line texture can be reduced.

[0020] It is characterized by invention according to claim 2 calculating the aforementioned diffuse density value, when the aforementioned diffuse density value operation means searches for the difference of the concentration value of the aforementioned attention pixel before binary gradation reappearance, and the addition result of the aforementioned random number addition means including a random number addition means by which the aforementioned random number can be added to the aforementioned reference value in addition to the composition of invention according to claim 1.

[0021] According to invention according to claim 2, the aforementioned diffuse density value calculates by searching for the difference of the concentration value of the aforementioned attention pixel before binary gradation reappearance, and the addition result of the aforementioned random number addition means.

[0022] Invention according to claim 3 is characterized by including a reference-value setting means to set up the

size of the aforementioned reference value, based on the pixel concentration of the predetermined pixel field which contains the aforementioned attention pixel among the pixel fields which constitute the aforementioned M value gradation picture in addition to the composition of invention according to claim 1.

[0023] Since the size of the aforementioned reference value is set up based on the pixel concentration of the predetermined pixel field which contains the aforementioned attention pixel among the pixel fields which constitute the aforementioned M value gradation picture according to invention according to claim 3, the gamma property according to the binary-ized object domain can also be acquired further.

[0024] In addition to the composition of invention according to claim 1, invention according to claim 4 is based on the pixel concentration of the predetermined pixel field which contains the aforementioned attention pixel among the pixel fields which constitute the aforementioned M value gradation picture. A distinction means to distinguish whether the aforementioned diffuse density value should be calculated using the aforementioned random number is included, the aforementioned diffuse density value operation means On condition that the distinction of a purport which should calculate the aforementioned diffuse density value using the aforementioned random number was made with the aforementioned distinction means, it is characterized by calculating the aforementioned diffuse density value using the aforementioned random number.

[0025] On condition that the distinction of a purport which should calculate the aforementioned diffuse density value using the aforementioned random number was made with the aforementioned distinction means, in order that the aforementioned diffuse density value may calculate using the aforementioned random number according to invention according to claim 4, the operation of the aforementioned diffuse density value which used the aforementioned random number only for the field with need is performed.

[0026] In addition to the composition of invention according to claim 4, invention according to claim 5 is characterized by the aforementioned distinction means performing the aforementioned distinction based on the maximum and the minimum value of pixel concentration in the aforementioned pixel field.

[0027] According to invention according to claim 5, since the aforementioned distinction is performed based on the maximum and the minimum value of pixel concentration in the aforementioned pixel field, distinction processing becomes easy.

[0028]

[Embodiments of the Invention] Hereafter, the image processing system which is one of the gestalten of the operation in this invention is explained, referring to a drawing.

[0029] Drawing 1 is a block diagram for explaining the composition and the processing outline of an image processing system 1. An image processing system 1 contains the picture input device 3 and the A/D-conversion equipment 4 which consist of a drive system which scans optoelectric transducers, such as MPU2 and CCD, and this, the Log inverter 5, the degree compensator 6 of acute (MTF compensator), gamma correction equipment 7, picture binary-ized equipment 8, and image recording equipment 9.

[0030] A picture input device 3 reads the mixture manuscript which consists of for example, a continuous tone picture, a line drawing, etc., and generates a sampling analog signal. A/D-conversion equipment 4 quantizes the sampling analog signal generated by the picture input device 3 as continuous tone reflection factor data in which 1 pixel has the value of 8 bits (256 gradation). The Log inverter 5 computes 8-bit continuous tone concentration data by carrying out logarithmic transformation of the quantized continuous tone reflection factor data. The degree compensator 6 of acute (MTF compensator) performs the degree amendment of acute of a 8-bit continuous tone concentration data picture using digital filters, such as for example, the Laplacian filter. Gamma correction equipment 7 performs a gamma correction, in order to amend the difference in the gradation curve of a picture input device 3 and image recording equipment 9 and to realize a gamma property desirable as the image processing system 1 whole Using RAM which functions as 256-word an about 8-bit LUT (look-up table), this gamma correction is performed, when nonlinear gamma correction data are set up by MPU2. Picture binary-ized equipment 8 changes into the 1-bit binary data according to light and darkness the 8-bit continuous tone concentration data by which the gamma correction was carried out using the error diffusion binary-ized method mentioned later. The changed 1-bit binary data are printed by the predetermined record medium with the image recording equipment 9 which consists of an electro photographic printer or an ink jet printer.

[0031] Drawing 2 is the block diagram showing the 1st operation gestalt of the error diffusion binary-ized processing performed with an image processing system 1. Moreover, drawing 3 is a flow chart which shows the procedure of error diffusion binary-ized processing of drawing 2. The content of processing of the error diffusion binary-ized processing concerning the 1st operation gestalt is explained in detail below, referring to drawing 2 and drawing 3.

[0032] the random number generator 23 with which the point that these 1st operation gestalten differ with reference to drawing 2 as compared with the block diagram of drawing 11 explained as conventional technology adds a random number to the High reference value HB and the Low reference value LB -- furthermore, it is in the point established The value to which the random number was added to the High reference value HB and the Low reference value LB is inputted, and one of values will be chosen as reference-value B'xy for binary-ized error E<sub>xy</sub> calculation, and will be outputted to a selector 19 at a subtractor 18.

[0033] If the content of processing is explained based on the flow chart of drawing 3, it will be judged first whether the attention pixel data I<sub>xy</sub> were inputted into the adder 16 (S1). The attention pixel data I<sub>xy</sub> are one of the pixels which constitute the above-mentioned 8-bit continuous tone concentration data by which the gamma correction was carried out, and are concentration data of the pixel used as a binary-ized object.

[0034] When there is no input of an attention pixel, it is judged whether binary-ized processing was completed about all the pixels of whether processing was completed and or not a multiple-value gradation input picture (S13).

[0035] And unless binary-ized processing is completed about no pixels, processing returns to S1 again.

[0036] If an attention pixel is inputted, the weighted-mean error E<sub>avxy</sub> which should be added to the concentration data of this attention pixel is computed (S2), and this weighted-mean error E<sub>avxy</sub> will be added to I<sub>xy</sub>, and will be

made into  $I'xy$  (S3). As shown in drawing 2,  $Eavxy$  is a value computed by the processing which used the error weighting filter 22, and it is computed by feeding back an input value.

[0037] Next, in a comparator 17, it is judged whether this  $I'xy$  is larger than threshold Th of binary-ized processing (S4). When  $I'xy$  is larger than Th, the output pixel concentration data  $Bxy$  after binary-izing are set as 1 (S5). On the other hand, when it is below threshold Th, the output pixel concentration data  $Bxy$  are set as 0 (S6). Moreover, set-up  $Bxy$  is outputted also to a selector 19.

[0038] Next, a random number ZRand (randmax) is extracted from a random number generator 23 (S7). Although the range of the value which a random number ZRand (it abbreviates to a random number Z hereafter) can take can be suitably defined in the range which does not spoil the quality of image of the picture acquired by the error diffusion method, it can consider carrying out to 10% – about 20% of the dynamic range of a pixel, for example. If a dynamic range is now set to 0–1, the value of a random number Z will be set to 0.1–0.2.

[0039] Next, it is judged whether  $Bxy$  set up by S5 or S6 is 1 (S8). When  $Bxy$  is 1, the value with which the random number Z was added to the High reference value HB is chosen by the selector 19, and is outputted to a subtractor 18 as reference-value  $B'xy$  (S9). On the other hand, when  $Bxy$  is not 1, it is  $Bxy=0$ , and the value with which the random number Z was added to the Low reference value LB is chosen by the selector 19, and is outputted to a subtractor 18 as reference-value  $B'xy$  (S10).

[0040] Next, the binary-ized error  $Exy$  is computed from pixel data  $I'xy$  [finishing / amendment] and reference-value  $B'xy$  obtained from the binary-ized result, and it is stored in the error storing section 21 (S11).

[0041] Next, an attention pixel position is updated (S12), when binary-ized processing is completed about no pixels, processing returns to the above S1 again (S13), and the above-mentioned processing is performed repeatedly.

[0042] Reduction of the peculiar striped pattern called Snake line texture which tends to be generated in case the picture of uniform concentration level with little distribution is binary-ization-processed since reference-value  $B'xy$  for computing the binary-ized error  $Exy$  is calculating with this 1st operation gestalt using the random number Z especially as explained above can be aimed at. Moreover, since processing is made without changing threshold Th at the time of binary-ization-processing so that only the binary-ized error  $Exy$  may be changed at random using a random number, as compared with the case where either of the feedback elements of error diffusion is controlled by the random number, it can prevent that the outstanding gradation expression capacity which is the feature of an error diffusion method declines as much as possible.

[0043] Drawing 4 is drawing in which being processed by the error diffusion binary-ized method shown in this operation gestalt, and showing the outputted example of a picture. The multiple-value gradation input picture of a processing object is the same as the multiple-value gradation input picture from which the processing result shown in drawing 12 was obtained. As a result of processing the same multiple-value gradation input picture a clear passage by illustration, in drawing 4, it turns out that the Snake line texture decreases as compared with the picture (drawing 12) which was processed by the conventional error diffusion binary-ized method, and was outputted, and the uniform pixel distribution is reproduced more faithfully. On the other hand, in spite of having performed the error variance about character "5" using the random number, it turns out that the line drawing is clearly reproduced as compared with drawing 12 that there is no inferiority in the repeatability of a picture.

[0044] Drawing 5 is the block diagram showing the 2nd operation form of the error diffusion binary-ized processing performed with an image processing system 1. The point that these 2nd operation forms differ as compared with the block diagram of drawing 2 explained as the 1st operation form is a point that the field distinction section 24 into which the attention pixel data  $Ixy$  are inputted is formed further.

[0045] The composition of the field distinction section 24 is shown in drawing 6. The field distinction section 24 has the line memory 27, the maximum / minimum value detection filter 28, and LUTs (look-up table) 29 and 30. The attention pixel data  $Ixy$  inputted are memorized one by one by the line memory 27. Four of these line memory 27 are prepared so that it can memorize by four lines. And whenever the attention pixel data  $Ixy$  are newly inputted, 25 pixels to a-x of the 5x5-game feudal estate region included focusing on the attention pixel \* are extracted, and "maximum" with a pixel concentration of 25 pixels, the "minimum value", and the "maximum-minimum value" are detected by maximum / minimum value detection filter 28, respectively. The "maximum" of 25 pixels and the "maximum-minimum value" are outputted to LUT29, and the "minimum value" and the "maximum-minimum value" are outputted to LUT30, respectively. LUT29 chooses the High reference value HB according to the value inputted from maximum / minimum value detection filter 28 from the table data memorized inside, and outputs it to an adder 25. Moreover, LUT30 chooses the Low reference value LB according to the value inputted from maximum / minimum value detection filter 28 from the table data memorized inside, and outputs it to an adder 26.

[0046] Drawing which illustrates the relation between the "maximum-minimum value" inputted into LUT29 and the High reference value HB chosen by LUT29 is shown in drawing 7. Moreover, drawing which illustrates the relation between the "maximum-minimum value" inputted into LUT30 and the Low reference value LB chosen by LUT30 is shown in drawing 8. In these drawings, a vertical axis shows the High reference value HB (Max) or the Low reference value LB (Min), and a horizontal axis shows the "maximum-minimum value" (Max-Min). Moreover, the gradation of a multiple-value gradation picture inputted is made into 8 bits (0–255).

[0047] It is necessary to binary-ization-process the partial field so that the property as for example, a photograph field etc. may appear strongly, so that it is necessary to binary-ization-process the partial field so that the property as for example, a character field etc. may appear strongly, so that the value of the "maximum-minimum value" becomes larger, and the value of the "maximum-minimum value" becomes smaller. If the table of LUTs 29 and 30 is set up so that the High reference value HB and the Low reference value LB may change and may be chosen according to the relation shown in drawing 7 and drawing 8, the gamma property suitable for the character field or the character field can be acquired.

[0048] Again, with reference to drawing 5, the High reference value HB set up in the field distinction section 24 and the Low reference value LB are inputted into an adder 25 and an adder 26, respectively. After this, the random

number generated with the random number generator 23 like the 1st operation form is added to the High reference value HB and the Low reference value LB, and is inputted into a selector 19. Since the following processings are the same as that of the 1st operation form, detailed explanation of the block diagram after this is omitted here.

[0049] As explained above, according to this 2nd operation gestalt, for example, the gamma property suitable for the character field or the photograph field can be acquired, and a Snake-Line texture can be reduced like the 1st operation gestalt by random number addition to the High reference value HB and the Low reference value LB. When the multiple-value gradation picture of the origin from which it followed, for example, the output picture of drawing 4 was acquired is processed with this 2nd operation gestalt, as compared with the 1st operation gestalt, the repeatability of character field "5" is more high, and a bird clapper is expected for the direction of this 2nd operation gestalt.

[0050] Drawing 9 is the block diagram showing the 3rd operation gestalt of the error diffusion binary-ized processing performed with an image processing system 1. In addition, in this drawing 9, illustration is omitted about the portion with same drawing 5 and composition of the 2nd operation gestalt. The composition which transposed the component which specifically consists of the random number generator 23 shown in drawing 5, the field distinction section 24, an adder 25, and an adder 26 to the composition of this drawing 9 serves as a whole block diagram concerning the 3rd operation gestalt.

[0051] As compared with the block diagram of drawing 5 explained as the 2nd operation gestalt, the point that these 3rd operation gestalten differ in operation is in the point that it is judged whether a random number is added to the High reference value HB outputted to a selector 19 (refer to drawing 5) and the Low reference value LB according to the "maximum-minimum value" of the pixel concentration of the pixel of the 5x5-game feudal estate region included focusing on attention pixel \*. the [ that is,, / which always adds a random number to the High reference value HB and the Low reference value LB / the 2nd operation gestalt or ] -- unlike 1 operation gestalt, with this 3rd operation gestalt, the existence (existence of the possibility of generating of a Snake-Line texture) of the need for random number addition is judged according to the state of a 5x5-game feudal estate region

[0052] If processing of the error diffusion binary-ized processing concerning the 3rd operation form is explained, it will be judged first whether the attention pixel data I<sub>xy</sub> were inputted into the adder 16 (S21) and attention pixel data will be inputted, referring to drawing 9 and drawing 10, and also drawing 5, calculation (S22) of the weighted-mean error E<sub>avxy</sub> and calculation (S23) of I<sub>xy</sub> will be performed. Next, the output pixel concentration data B<sub>xy</sub> are computed by I<sub>xy</sub> being compared with threshold Th1 of binary-ized processing (S4) (S25, S26).

[0053] Next, in the field distinction section 24, the "maximum-minimum value" (Max-Min) of the pixel concentration of the pixel of the 5x5-game feudal estate region included focusing on attention pixel \* calculates (S27). The field distinction section 24 has the same maximum / minimum value detection filter 28 as the 2nd operation form, and the line memory 27. Maximum / minimum value detection filter 28 detects the "maximum-minimum value" of the pixel of a 5x5-game feudal estate region by these S27. In addition, unlike the 2nd operation form, LUTs 29 and 30 are not constituted by the field distinction section 24.

[0054] Next, it is judged by the comparator 31 whether the "maximum-minimum value" (Max-Min) is smaller than threshold Th2. This Th2 is a threshold for distinguishing whether it is the field which a Snake-Line texture may generate, when the 5x5-game feudal estate region put whether it was the field which has a uniform concentration distribution property with little distribution especially in another way and it binary-ization-processes, without using a random number Z. Since the "maximum-minimum value" is considered that 5x five-game feudal estate region is a field which has a uniform concentration distribution property with little distribution especially when smaller than threshold Th2, the signal which shows that from a comparator 31 is outputted to selectors 32 and 33.

[0055] A selector 32 chooses whether according to the signal inputted from a comparator 31, the random number Z inputted into the High reference value HB from a random number generator 23 is added, and outputs the High reference value HB to a selector 19 (refer to drawing 5). On the other hand, a selector 33 chooses whether according to the signal inputted from a comparator 31, the random number Z inputted into the Low reference value LB from a random number generator 23 is added, and outputs the Low reference value LB to a selector 19 (refer to drawing 5).

[0056] Therefore, if judgment of YES is made by S28, a random number Z will be added to the High reference value HB and the Low reference value LB by selectors 32 and 33 (S29), and an addition result will be outputted to a selector 19 as the High reference value HB and a Low reference value LB (S30). On the other hand, the High reference value HB and the Low reference value LB are outputted to a selector 19 as it is from selectors 32 and 33, without adding a random number Z, if judgment of NO is made by S28 (S30).

[0057] In addition, the range of the value of a random number Z can consider carrying out to 10% - about 20% of the dynamic range of a pixel like the 1st operation form.

[0058] Next, according to the value of the output pixel concentration data B<sub>xy</sub>, reference-value B'xy at the time of computing a binary-ized error is set as the High reference value HB or the Low reference value LB (S31, S32, S33), and the binary-ized error E<sub>xy</sub> is computed (S34). Then, the aforementioned processing is repeatedly performed until an attention pixel position is updated (S35) and binary-ized processing is completed about all pixels (S36).

[0059] According to this 3rd operation form, as explained above, according to the state of a 5x5-game feudal estate region, the existence (existence of the possibility of generating of a Snake-Line texture) of the need for random number addition is judged, and a random number is not added case [ whose 5x5 game feudal estate region is / like for example, a character field ]. Therefore, it can prevent un-arranging [ which random number addition processing is performed to \*\* to the field where the possibility of generating of a Snake-Line texture is low, and causes deterioration of quality of image on the contrary ]. Moreover, it can also prevent random number addition processing being performed vainly and reducing the speed of binary-ized processing. This brings an effective operation especially to processing speed in an error diffusion method with much difficulty.

[0060] Next, the modifications of each operation form explained above are enumerated.

- (1) Although added to the High reference value HB and the Low reference value LB, you may constitute a random number Z so that it may subtract from the High reference value HB and the Low reference value LB.
- [0061] (2) After a random number Z is added to the High reference value HB or the Low reference value LB, this value as a procedure of binary-ized error calculation Although it constitutes so that it may subtract from I'xy, after subtracting a random number Z from I'xy, you may subtract the High reference value HB or the Low reference value LB. What is necessary is to prepare a subtractor between an adder 16 and a subtractor 18 in drawing 2 in this case, and just to constitute a random number generator 26 so that a random number Z may be outputted to the subtractor.
- [0062] (3) You may constitute a random number generator 23 so that a random number which is different with the High reference value HB and the Low reference value LB, respectively may be generated. In this case, you may make it change the generating period of a random number etc., using the range of a random number as the same, or may make it the ranges of a random number differ.

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[Translation done.]

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- 1.This document has been translated by computer. So the translation may not reflect the original precisely.
- 2.\*\*\*\* shows the word which can not be translated.
- 3.In the drawings, any words are not translated.

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**DESCRIPTION OF DRAWINGS**

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[Brief Description of the Drawings]

[Drawing 1] It is the block diagram showing the outline composition of an image processing system 1.

[Drawing 2] It is a block diagram for explaining control processing of an image processing system 1 (the 1st operation gestalt).

[Drawing 3] It is a flow chart for explaining control processing of an image processing system 1 (the 1st operation gestalt).

[Drawing 4] It is drawing showing the example of an output picture in which reduction of a Snake-Line texture was achieved by binary-ized processing by the image processing system 1.

[Drawing 5] It is a block diagram for explaining control processing of an image processing system 1 (the 2nd operation gestalt).

[Drawing 6] It is a block diagram for explaining control processing of an image processing system 1 (the 2nd operation gestalt).

[Drawing 7] It is drawing which illustrates the relation between the High reference value HB (Max) chosen with an image processing system 1, and the "maximum-minimum value" of the pixel of a 5x5-game feudal estate region.

[Drawing 8] It is drawing which illustrates the relation between the Low reference value LB (Min) chosen with an image processing system 1, and the "maximum-minimum value" of the pixel of a 5x5-game feudal estate region.

[Drawing 9] It is a block diagram for explaining control processing of an image processing system 1 (the 3rd operation gestalt).

[Drawing 10] It is a flow chart for explaining control processing of an image processing system 1 (the 3rd operation gestalt).

[Drawing 11] It is a block diagram for explaining control processing of the conventional image processing system.

[Drawing 12] It is drawing showing the Snake-Line texture which appears notably by binary-ized processing by the conventional image processing system.

[Description of Notations]

1 Image Processing System

8 Picture Binary-ized Equipment

17 Comparator

19 Selector

21 Error Storing Section

22 Error Weighting Filter

23 Random Number Generator

24 Field Distinction Section

27 Line Memory

28 Maximum / Minimum Value Detection Filter

29 30 LUT (look-up table)

31 Comparator

32 33 Selector

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[Translation done.]